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The economic valuation of natural hazards in mountain forests: An approach based on the replacement cost method

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ABSTRACT

Protection from natural hazards is the most important function of mountain forests from an ecological, economic and social point of view. This assertion has been widely debated in recent years by a number of authors. In this paper we focus on the economic aspects of the protective function of forests, developing a quick and simple estimation method that can be applied on a local scale. We present the results of its application in an Italian Alpine forest. After having identified the main forest attributes directly or indirectly involved in protection, the economic value of the protective function for homogeneous zones was estimated by applying the replacement cost method. This value enables environmental concerns to be included in forest planning and political decision-making.

Introduction

The most important ecological and economic function of mountain forests is to protect soil, slopes and human activities from hydro-geological hazards (Merlo and Rojas Briales, 2000). There have been many ecological studies that have attempted to quantify the importance and dynamics

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of the protective function of forests (Bebi et al., 2001); however, few have considered the economic aspects. Those that have considered the economic aspects have reported varying results due to their use of different methodological approaches (Olschewski et al., 2012). Despite these differences, some authors attribute a higher economic value to this function of mountain forests than to their production (timber and non-timber) and recreation functions (Notaro et al., 2009; Goio et al., 2008).

The protective role of forests applies to three main types of natural hazards (Berger and Rey, 2004): (i) rockfalls, (ii) snow slippage and avalanches, and (iii) landslides. Multi-functional forest management, according to the third Ministerial Conference for the Protection of Forests in Europe (MCPFE – Lisbon, 1998), includes both direct and indirect forest protection. While indirect protection amounts to prevention of soil erosion and regulation of water flow, direct protection involves safeguarding human life and activities from natural hazards (Motta and Haudemand, 2000). Zoning with respect to the main function is of great importance in multi-functional forest planning (Kangas and Store, 2002). At present, experts who determine the main function of each zone do not consider economic data, which brings into question the usefulness of their evaluations, which are based on a limited selection of the relevant data. The economic valuation of forest functions would allow forest managers to make more effective decisions, as they could compare the relative importance of each single function more objectively. Techniques for estimating non-market forest values include revealed and stated preference methods and cost-based approaches. Replacement cost, preventive expenditure and opportunity cost methods fall into this last class of evaluation techniques (Freeman III, 2003). Combining economic and ecological approaches provides a better way to identify the main forest function in each zone and thus provides essential support for forest-planning and management.

The aim of this paper is to develop a simple and expeditious method to estimate the protective function of forests based on the replacement cost method and to present the results of its application in an Italian Alpine forest. This methodology integrates ecological/physical and economic data and can easily be applied by forest managers to identify the main forest functions in a forest management plan.

Materials and methods

Study area and procedure

This study was carried out in the eastern Italian Alps in the province of Trento. Trentino has 345,180 ha of forested land (approximately 56% of the total area), with predominantly Norway spruce (59%), European larch (17.0%) and Silver fir (10.8%) forests. This Italian province has a long tradition of forest management, and 75.5% of the forest area is managed according to a detailed forest plan. The area studied is the mountain forest of Valdastico. It covers 269 ha at an altitude ranging from a minimum of 620 m to a maximum of 1350 m.

The suggested methodology was designed to provide a simple and quick tool for the economic valuation of the protective function of forests at the forest planning level. This methodology combines easy-to-collect ecological and economic data. It differs from those applied on much larger scales (national and regional) in the types of attributes considered and the degree of detail achieved.

The first phase of the procedure relies on ecological and physical data. We have identified the main forest attributes directly or indirectly involved in protection, and we have assigned scores to each attribute in relation to its capacity to protect soil, slopes and human activities from hydro-geological hazards. Forest managers can apply these scores directly to the forest attributes included in their forest management plan to calculate the level of protection for homogeneous zones. Each planning zone is homogeneous in the following aspects: forest tree composition (forest types), stand development stage, silvicultural system and treatments. The translation from ecological and physical data to economic data was achieved using the replacement cost method implemented for homogeneous zones. We suggest the most appropriate type of natural engineering intervention for each level of protection to substitute the forest in such a way that both forest ecosystems and human infrastructure can be protected. It is thus possible to calculate precisely the cost of replacement based on the characteristics of the land in each zone.